

Quiz 162q

Show all work in all parts to receive maximum credit

Name KEY

$R = 0.0821 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K}$ or $8.314 \text{ J}/\text{mol}\cdot\text{K}$

1) (15 points) The Jovian atmosphere contains ammonium hydrogen sulfide that decomposes according to the following equilibrium equation: $\text{NH}_4\text{SH}(\text{g}) \rightleftharpoons \text{NH}_3(\text{g}) + \text{H}_2\text{S}(\text{g})$ $K_p = 0.126$ at 24°C . A 1.000 mole sample of NH_4SH is placed in a 1000. mL container and the system achieves equilibrium at some later time.

(2) a) Write K_p in terms of the reactants and products.

$$\frac{P_{\text{NH}_3} \cdot P_{\text{H}_2\text{S}}}{P_{\text{NH}_4\text{SH}}} = K_p$$

(1) b) Calculate K_c at 24°C .

(6) c) Set up an I.C.E. table and calculate $[\text{NH}_4\text{SH}]_{\text{eq}}$, $[\text{NH}_3]_{\text{eq}}$, and $[\text{H}_2\text{S}]_{\text{eq}}$ in units of molarity. Be sure to check your answer.

3) d) If the equilibrium mixture determined in part c is transferred to a 2.000 L container calculate a reaction quotient (Q_c) and determine which direction the reaction will shift to compensate for the change. Explain your decision.

$Q_c = \frac{(0.0346_8)(0.0346_8)}{0.465_4} = 2.58_4 \times 10^{-3}$ $Q_c < K_c$ shift right

(1) e) Do you think the forward reaction is exothermic or endothermic? Explain your answer.

(1) f) If the temperature is increased will the value of K_p be larger or smaller than that at 24°C . Explain.

b) $K_p = K_c(RT)^{\Delta n}$ $K_c = \frac{K_p}{(RT)^{2-1}} = \frac{0.126}{(0.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}} \cdot 297\text{K})}$

$K_c = 5.16_7 \times 10^{-3}$

c)

	$[\text{NH}_4\text{SH}]$	$[\text{NH}_3]$	$[\text{H}_2\text{S}]$
i	1.000 M	\emptyset	\emptyset
c	-x	+x	+x
e	$1.000-x$	x	x

$\frac{x^2}{(1.000-x)} = 5.16_7 \times 10^{-3}$

$x^2 + (5.16_7 \times 10^{-3})x - 5.16_7 \times 10^{-3} = 0$

$x = -0.0745_1$ or 0.0693_5 M

$[\text{NH}_4\text{SH}]_{\text{eq}} = (1.000 - 0.0693_5) \text{ M} = 0.930_7 \text{ M}$

$[\text{NH}_3] = [\text{H}_2\text{S}] = 0.0693_5 \text{ M}$

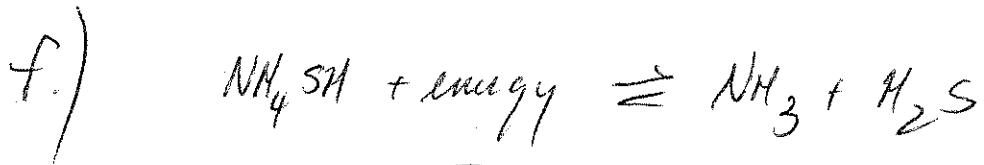
d) $[\text{NH}_4\text{SH}]_c = \frac{0.930_7 \text{ M} \times 1.000 \text{ L}}{2.000 \text{ L}} = 0.465_4 \text{ M}$ $[\text{NH}_3]_c = [\text{H}_2\text{S}]_c = \frac{0.0693_5 \text{ M} \times 1.000 \text{ L}}{2.000 \text{ L}} = 0.0346_8 \text{ M}$

d.) Since volume has expanded pressure for all species will decrease. The pressure decrease is greater for the products and will lead to a $Q_c < K_c$.

In order to return the system to equilibrium (K_c) the reactant will decompose into two gas particles to reach K_c .

e.) This is a decomposition of one reactant.

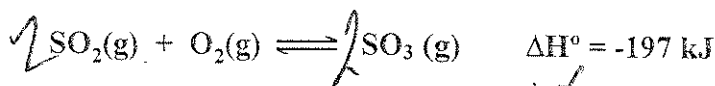
This will require energy to be added - endothermic



raising Temp increases the available energy for the reaction. Since the rxn is endothermic, the additional energy will be used to shift the equilibrium to the right permanently as long as the new temp. is maintained.

Thus K_p gets larger.

2) (5 points) Determine the shift (left or right) to oppose the given change to the following equilibrium reaction:



a) oxygen is added

right

b) volume of reaction vessel is decreased

right

c) the pressure is increased by adding argon gas

no change

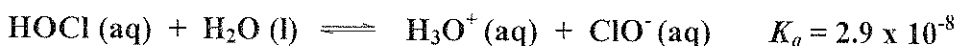
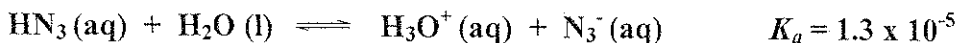
d) the temperature is decreased

right

e) sulfur dioxide gas is removed

left

3) (5 points) Given the following equilibria:



(2)a) Determine which acid, HN_3 or HOCl , is stronger. Explain your answer.

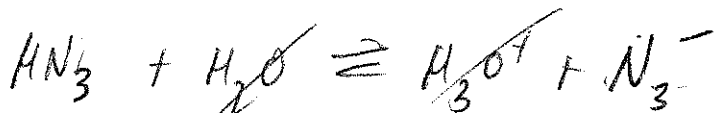
HN_3 $K_a > \text{HOCl}$ K_a

(1)b) Predict which side is favored for the following equilibrium:

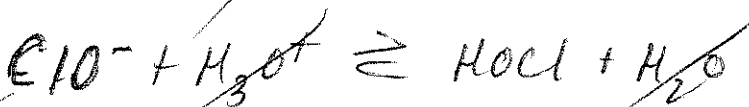


Right side is favored. The weaker, more stable, acid is favored.

(1)c) Support your answer in part b by calculating the K_c value for the equilibrium in part b.



$$K_a = 1.3 \times 10^{-5}$$



$$\frac{1}{K_a} = \frac{1}{2.9 \times 10^{-8}}$$



$$K_c = K_a$$

$$\frac{K_{\text{HN}_3}}{K_{\text{HOCl}}} = 4.4 \times 10^2$$